Not to be cited without
permission of the author(s)[1]

Canadian Atlantic Fisheries
Scientific Advisory Committee

CAFSAC Research Document 85/89

Ne pas citer sans
autorisation des auteur(s)[1]

Comité scientifique consultatif des
pêches canadiennes dans l'Atlantique

CSCPCA Document de recherche 85/89

The Canadian Offshore Lobster Fishery 1971-1984: Catch History, Stock Condition, and Management Options

By

D.S. Pezzack and D.R. Duggan
Invertebrates and Marine Plants Division
Fisheries Research Branch
Halifax Fisheries Research Laboratory
Department of Fisheries and Oceans
Scotia-Fundy Region
P.O. Box 550
Halifax, N.S.
B3J 2S7

[1]This series documents the scientific basis for fisheries management advice in Atlantic Canada. As such, it addresses the issues of the day in the time frames required and the Research Documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

Research Documents are produced in the official language in which they are provided to the Secretariat by the author(s).

[1]Cette série documente les bases scientifiques des conseils de gestion des pêches sur la côte atlantique du Canada. Comme telle elle couvre les problèmes actuels selon les échéanciers voulus et les Documents de recherche qu'elle contient ne doivent pas être considérés comme des énoncés finals sur les sujets traités mais plutôt comme des rapports d'étape sur les études en cours.

Les Documents de recherche sont publiés dans la langue officielle utilisée par les auteur(s) dans le manuscrit envoyé au secrétariat.

Abstract

The Canadian offshore lobster fishery grew rapidly from its beginning in 1971 and catches reached 678 t in 1976, at which time pressure from inshore lobster fishermen resulted in catch and effort restrictions which limited further expansion. The catch and effort trends are examined, but it is shown that changes in CPUE are not a reliable indication of stock size. Size frequency distributions have shown no change since the initial samples taken in 1972-1973, suggesting that the fishery has had little effect on the stock. The history and effectiveness of the various catch and effort controls are discussed. Under the present quota system, season and trap limits serve no conservation value. The extension of the NAFO Div. 4X quota to include the Div. 5Ze fishery is not suggested though modification of the Div. 4X quota area to include the northern half of Div. 5Ze is advocated if accompanied by a change in the quota levels. The quota itself is based on the 1974-1976 catches, not on biomass estimates, and could be modified.

Résumé

La pêche hauturière canadienne au homard a augmenté rapidement depuis ses débuts en 1971, et les prises ont atteint 678 t en 1976. C'est alors que, sous les pressions exercées par les pêcheurs côtiers, des restrictions ont été imposées sur les prises et les efforts, ce qui a mis un frein à l'expansion de la pêche hauturière. Les tendances dans les prises et les effort sont examinées, mais il est démontré que les changements dans le PUE ne donnent pas une indication valable de la taille du stock. Les distributions de fréquence des tailles n'ont pas varié, depuis le prélèvement des premiers échantillons en 1972-1973, ce qui montre que la pêche a eu peu d'effet sur le stock. L'historique et l'efficacité des diverses mesures de restriction imposées sur les prises et sur les efforts sont analysés. Dans le système de quotas actuel, les limites pour la saison et pour les cages n'ont rien à voir avec la conservation de l'espèce. On ne propose pas d'étendre les quotas de la division 4X de l'OPANO à la pêche dans la Division 5Ze bien qu'on recommande d'étendre les quotas de la Div. 4X à la moitié nord de la Div. 5Ze à la condition que les quotas soient modifiés. Chaque quota est basé sur les prises de 1974 à 1976 et non sur les estimations de la biomasse, et il peut être modifié.

Introduction

The Canadian offshore lobster fishery was established in 1971 as an alternative for the 56 displaced swordfish vessels (Stasko and Pye 1980a; Pezzack and Duggan 1983). The fishery was controversial from its conception, but in the beginning the only restrictions placed on the experimental fishery were: must fish beyond the offshore lobster boundary line drawn 92 km (50 naut mi) from shore (Figure 1); must use traps; no taking of berried females; and minimum size 81 mm. In 1976 at the height of an emotional protest by inshore lobster fishermen, licenses were frozen to the eight vessels active in the fishery, and a precautionary quota (68 t per vessel), trap limit (1,000 traps per vessel), and 9-month season were established (Pezzack and Duggan 1983). In 1979, a 5400 km^2 area closed to all lobster fishing was established on and around Browns Bank (Figure 2), removing a rich offshore lobster ground, equal in area to one third of the commercially fished NAFO Div. 4X offshore grounds.

Methodology

Catch and effort data were obtained from the offshore lobster vessel logbooks, which each vessel is required to submit, sales slips from the buyers, and fishery officer reports. The rate of log record returns has been greater than 95% since 1977, and sales slips close to 100%.

The offshore lobster district is divided into three main assessment areas (Figure 2): Northeast Georges Bank (Subdiv. 5Zj, 5Zm), Southeast Browns Bank (Subdiv. 4Xn), and West Browns Bank (Subdiv. 4Xp, 4Xq)(at times divided into Southwest Browns Bank and Truxton Swell).

Annual catch per unit effort (CPUE) is calculated by dividing the total annual catch by total number of traps hauled (kg/TH).

Catch/Effort History, 1972-1984

Catch/effort data for 1972-1982 have been previously presented by Pezzack and Duggan (1983). Annual catch (tonnes), effort (trap hauls), and CPUE (kilograms/trap haul) are summarized in Tables 1 and 2 and Figures 3-5. Between 1971 and 1976 catches increased on the Scotian Shelf from 8 to 496 t (1976) while on Georges Bank catches reached a plateau of 135-182 t between 1972 and 1976. The Scotian Shelf fishery developed first on S.E. Browns Bank but by 1973 W.Browns Bank accounted for 43% of the Div. 4X catch. An increase in the W.Browns Bank catch occurred in 1976 and effort shifted away from S.E.Browns Bank. High catches along the northern edge of the Northeast Channel and in the Truxton Swell region accounted for much of the increase. Catches and CPUE's declined on S.E.Browns Bank until 1978 when an upswing began which peaked in 1981 with record high CPUE levels (4.06 kg/TH). West Browns Bank catches and CPUE's remained relatively high until after

1979 when the rich grounds on the northern edge of the channel were closed to lobster fishing as part of the Browns Bank closure area. Effort shifted from W. Browns Bank to S.E. Browns Bank and by 1980 the Truxton Swell region was abandoned due to declining catch rates. Following the introduction of the 68 t boat quota for Div. 4X in 1977, some Scotian Shelf effort shifted to Georges Bank and the Georges Bank catches peaked in 1978. The trend was short lived as vessels found limited space in the face of an expanding American fishery. Catches declined, though CPUE's remained high; and by 1980 only the two original vessels which are restricted to Div. 5Ze remained on Georges Bank. The total Div. 4X catches remained relatively stable from 1977 to 1981. CPUE's increased on S.E. Browns Bank and Georges Bank in 1981, with a smaller increase on S.W.. Browns Bank.

A sudden shift in CPUE's and catch trends occurred in 1982 as catches and CPUE's dropped to the lowest levels since the 1974-1975 period. The drop in CPUE's was exaggerated by fishermen moving to previously unfished and unfamiliar grounds in search of lobster and by an increase in effort as fishermen fished the entire 9-month season, even during seasons of normally low CPUE. Catches on W.Browns Bank showed a major recovery in the fall as a vessel moved back to the Truxton Swell-Crowell Basin area and found large seasonally available concentrations of lobsters. The adjoining grounds on S.W. Browns Bank also showed higher than average fall landings.

Catches showed an increase in 1983 on W. Browns Bank as effort and CPUE increased. CPUE's increased only slightly on S.E. Browns Bank and Georges Bank but catches remained low. CPUE's continued their moderate rise in 1984, but reduced effort resulted in lower catches.

The small size of the fishery, with only eight licences and in recent years only six to seven vessels active in the fishery, makes any analysis of catch effort trend difficult as a single vessel can account for over 50% of the effort in a given area. Any change in fishing patterns can result in major changes in the catch and effort of an area. The recent sinking of two vessels (1981, 1984) and the retiring or quitting of three experienced vessel captains has resulted in some reduced effort and catches.

A comparison of Div. 4X catch data with the total landings of north eastern Georges Bank and central Georges Bank (Figure 6) indicates a consistent pattern over the entire area. All areas showed a peak in landings during the mid 1970's and a decline in the late 1970's and early 1980's. USA landings from Georges Bank have recovered, with annual increases of 12% per year since 1981.

It is not known if the observed changes in catch are a result of changes in biomass or catchability. Biomass estimates (Fogarty et al. 1982) indicate a slight increase in the biomass of northeastern Georges Bank in the late 1970's after a period of decline in the 1960's. Similar data for the Scotian Shelf and Gulf of Maine indicated major increases in

the biomass from a low in the mid 1960's. The data suggest the possibility of large scale cyclic changes in the population possibly related to environmental changes.

Stock Assessment Methods

CPUE

The health of the Canadian offshore lobster fishery has traditionally been assessed by examining the trends in annual CPUE's (Stasko and Pye 1980a) and size frequency (Stasko and Pye 1980b). The relationship between CPUE and stock size has never been fully examined for this fishery. In theory CPUE is proportional to the average population on hand while fishing is in progress (Ricker 1940), but this is based on several assumptions being valid: (1)fishing effort is proportional to fishing mortality; (2) catchability is constant; (3) area fished encompasses the range of the stock; and (4) effort equally distributed over area and time.

CPUE has been defined as kilograms of legal lobsters landed (does not include ovigerous females, sublegal-size, or soft-shell lobsters thrown back at sea) per trap hauled (as recorded in fishermen's logbooks). No corrections are made for different trap designs, soak time (SOD), bait quality and quantity, vessel size, age and efficiency, or the vessel captain's skill and ability to learn over time.

No data exist on the efficiency of different trap types in catching large, mature lobsters, but there are indications in the fishery that vessels fishing almost side by side with different trap types catch a different proportion of the large and small lobsters, futhermore, the efficiency of different trap designs may differ as a function of population density (Rothschild 1977). Over the years construction materials, entry size, and lathe spacing have changed several times, and a mixture can now be seen in the gear fished.

Studies have shown a relationship between SOD and CPUE (Bennett 1974; Bennett and Brown 1979; Skud 1979; Austin 1977) and emphasized the need to correct for SOD. The relationship between catch and SOD varies with season, area, lobster density, bottom temperature, bait, and competing species (crab and the bait-devouring amphipods and isopods or "sea fleas"). Offshore fishermen prefer to use a 6-day SOD, and data suggest that catch per trap increases up to that time (Skud 1979). Regulations limit the fishermen to 1,000 traps, and this forces the fishermen to fish much of the gear after only a 3-day SOD. The mixture of SOD on a single trip makes reliable data on SOD and the associated catch difficult to obtain, and with presently available data a usable standardization factor is not possible.

Vessel design, size, and age do not have as direct an effect on CPUE in a trap fishery as it would in a trawl fishery; but vessel size and age can determine the sea-worthiness of a vessel which will effect the seasons

fished. Size will influence how often traps are hauled in a season and the speed and ease with which they can be moved in response to changing catch rates. The present fleet consists of seven vessels, five of which fished the full season in 1984. With a median age of 15 yrs (6-30 yr) efficiency has likely been declining in recent years.

Experience, knowledge, motivation, and adaptability are important but unquantifiable variables in a vessel's captain and crew. Hilbon and Ledbetter (1985) estimated that in the British Columbia salmon seine fishery 20-24% of the intervessel differences were accounted for by differences in the captain and crew. The small size of the fishery (eight licences) makes any changes in vessel captains important.

The introduction of the quota in 1977 disrupted natural fishing patterns by requiring the successful vessels with generally higher CPUE's to leave the fishery once their quota was reached. The remaining vessels with generally lower CPUE values would continue to fish the remainder of the year. Prior to the quota the highliners would continue to fish later in the year and maintain overall CPUE's at a higher level.

Any attempts to standardize effort will be wrought with difficulties. The year-to-year changes in vessels, captains, gear parameters, fishing locations, months fished, SOD, etc., make a standardized unit of effort difficult to calculate. In a large fishery differences between vessels can be averaged over a large number of vessels and individual variation will have little effect on the overall catch rates; but in a fleet of eight vessels fishing three areas, individual variation is of major importance.

The catchability factor is important in relating CPUE to population size, and if the factor varies over time the year-to-year comparisons may be impossible (Ricker 1975). The Canadian offshore fishery in Div. 4X only fishes a portion of the stock with some portion of it lying inside the 50-naut mi line and since 1979 a large portion in the Brown Bank closure area. Some lobsters may not be exposed to fishing effort at any time during the year, while others may be exposed only during the migration from deeper winter grounds to the shallower areas of the closed area or inside the 50-naut mi line. Tagging data (Pezzack and Duggan unpublished) indicates a major seasonal migration from S.E. Browns Bank into the closed area and across to the S.W. Browns Bank area.

Commercial concentrations of lobster are centred in a few small areas of the Scotian Shelf as shown by the distribution of catch per square kilometer in Figure 7. These concentrations lie close to the offshore boundary line and the closed area. Between 60% and 70% of the Div. 4X landings are taken within 10 naut mi of an area closed to offshore fishing and on S.W. Browns Bank a high proportion of the catch is caught within 5 naut mi of the non-fishing areas. In a highly migratory species which undertake seasonal migrations of 50 to 200 km such distances are small. Minor changes in distribution or timing and direction of migrations could result in

significant changes in the availability of lobsters from year-to-year. If temperature is the mediating factor in lobster movement as suggested by Uzmann et al. (1977), changes in the amount of warm slope water entering the Northeast Channel and Gulf of Maine system (Mountain 1982) could explain some of the observed variation in catches.

The lack of standard effort units, and potential major year-to-year changes in lobster catchability makes the simple comparison of annual or seasonal CPUE's potentially misleading.

Changes in Size Frequency

Size frequency distributions of the offshore catch have been monitored to detect changes which would indicate changes in the stock structure (Stasko and Pye 1980b). The offshore stocks were virtually unfished prior to the start of the offshore fishery in 1971 (lobster bycatch from foreign trawlers may have occurred), and like most new fisheries it was expected that a decline in size would occur once subjected to heavy fishing effort and the removal of the larger individuals (Ricker 1977). This trend was seen in the New England inshore fishery during the mid 1800's (Hernick 1909), the Canadian inshore fishery in the late 1800's (Venning 1910), and the southern New England offshore fishery in the 1950's and 1960's (Skud 1969; Cooper and Uzmann 1980).

A comparison of at-sea samples from S.E. Browns Bank in 1972 (less then 1 year after fishing began) and July 1983 (Figure 8) shows a similar size frequency with less difference than between samples from April 1983 and August 1984 (Figure 9). Observed seasonal and yearly differences may be related to the depth of fishing and exact fishing locations. Skud (1969) observed an increase in mean size with increased depth.

Size frequency comparisons on S.W. Browns Bank are complicated by the closure in 1979 of the area sampled in 1973 and the lack of samples from the same periods of the year. Data from at-sea samples taken in July 1973 and November 1978 are compared with data from trapping surveys in May and September 1984 (Figure 10). The data show no decrease in size from 1973 to 1978, and an apparent increase since the area was closed to lobster fishing.

Some caution must be observed in interpreting the data since the size selectivity of the gear is unknown and may mask true population changes. The lack of change in the size frequency in the catch, is in sharp contrast to the 30 mm decline in mean size observed by Skud (1969) over a 10-yr period (1956-1967) of intensive trawl fishing on southern Georges Bank. The mean size decreased from an "offshore" type size frequency with a mean size of 120 mm to an "inshore" type distribution with a mean size of 90 mm. Indications are that the mean size on southern Georges Bank has continued to decrease (Cooper and Uzmann 1980).

At-sea samples have shown a recent increase in sublegal-size lobster in the catches from West Browns Bank, and

fishermen confirm that they are more plentiful than at any time they remember. Sublegal-size lobsters have always been found in small numbers on West Browns Bank and were more common in the Truxton Swell area. Small lobsters have been observed at all depths in the canyons on Georges Bank (Cooper and Uzmann 1980) but were most plentiful in the shallower shoal waters. During the 1975 offshore tagging program over 20% of the 1300 lobsters tagged in the shoal waters of Browns Bank were <81 mm. The absence of sublegal-size lobsters from much of the offshore catch is due in part to the fact that the fishery is restricted to the deeper waters. The present increase in sublegal-size lobsters may be the result of a recruitment pulse originating during the warm period of the mid 1970's. During the early 1980's an increase in recruits to the inshore fisheries has been seen on a wide scale, from Northumberland Strait to S.W. Nova Scotia.

Conclusion on Assessment Methods

CPUE's are not a reliable indicator of year-to-year changes in stock abundance as wide changes in CPUE can be expected from small changes in fishing patterns and lobster distribution or migration patterns. The closure of Browns Bank in 1979 may be expected to increase the year-to-year variations as the fishermen are no longer able to follow changes in distribution.

The stability of the size frequency suggest that the fishery has had little impact on the stock, but work must be done to determine the selectivity of the traps and the relationship between trap caught and true population size frequencies.

Regulations: History and Impact

Public protest and demonstrations by inshore lobster fishermen in 1976 led to a series of restrictions being placed on the offshore lobster fishery. The offshore fishery was never popular with the inshore fishermen who feared that the new fishery would remove lobsters vital to their fishery, and they resented the special nature of the fishery with large company-owned vessels and no season or trap limits. A poor inshore fall season in 1976 coupled with reports of record high landings offshore (Figure 11) led to protest and threats of violence against the offshore fleet. Faced with this pressure managers froze the number of offshore licences at eight, and examined various control methods in consultation with the offshore vessel owners. The result was a combination of effort controls in the form of season and trap limits, and catch control in the form of boat quotas. The industry accepted the regulations as their only means of saving the fishery from complete closure. The regulations were not based on scientific advice since little was known of the stock. A review of correspondence from the time shows that some of the information

available at the time was in retrospect incorrect. It was believed that the size of offshore lobsters had decreased significantly. This appears to have been based on a fishery officer's observation of landed catch, but did not account for the fact that vessels had shifted their effort from Georges Bank, with its large lobsters to the Browns Bank area where lobsters are generally smaller. In fact, no major change has been noted between 1972 and 1983. A second misconception was that a 43.6% increase in landings between 1975 and 1976 (the actual increase was only 24.4%) was due to increased effort which it was feared would continue to increase if unchecked. In fact, effort had only increased by 7-10%, and the major part of the increased landings was due to higher CPUE's.

Season

Initially there was pressure from the inshore lobster fishermen to make the offshore fishery to conform with the Lobster District 4 season (last Tuesday in November to May 31), but it was realized by managers that this would close down the predominantly late spring-early summer offshore fishery. A 3-mo closed season was suggested with the choice of July 15 to October 15 or December 15 to March 15. The former was favoured by the owners of larger vessels which could fish during the winter months while the latter was favoured by the owners of the smaller vessels. In 1977 the season was removed from vessels fishing Div. 5Ze and by 1980 the rule was relaxed to any 3-mo.

The season does little to reduce effort since prior to 1977 the vessels stopped fishing for 2-4 mo for summer refit when CPUE's were lower and soft-shelled lobsters were present, or in winter to avoid poor weather. The seasons in some years reduces the flexibility of the fleet to respond to unexpected changes in catch rates, weather and to unforeseen vessel. problems.

Trap Limit

There was pressure to limit the offshore vessels to the same 375 trap limit as Lobster District 4. At that time offshore vessels were using 800-1,200 traps. The owners of the larger vessels requested 1,200-1,500 traps while the smaller vessel owners felt 800-1,000 was sufficient. A fourth suggestion was made to base it on crew size with 375 traps per two crew members or 1125-1,500 per vessel. The resulting regulation was 1,000 traps per vessel regardless of vessel size.

The trap limit may have reduced the efficiency of the fleet by forcing the fishermen to fish traps with suboptimal SOD. Fishermen insist and field observation and data (Skud 1979) tend to support the fact that a SOD of less than 5-6 d produces lower catches. This is generally longer than that used by inshore fishermen who may haul traps daily, but the

density of lobsters in the offshore region is estimated at 0.1 to 5% that of inshore regions (Cooper and Uzmann 1980). Vessels which fish 400 traps per day must either reduce trips to 3 d with the resulting increased number of trips to and from the fishing grounds, or haul traps a second time with only a 2-3 d set and a lower CPUE.

The trap limit has little conservation value in the offshore fishery since each vessel is already limited by a quota. If left to the economic demands of the fishey each vessel would find its own optimal level.

Quota

The quota was designed to stop the apparent rapid expansion of the fishery in the early 1970's, until more was known as to its impact on the inshore stocks. The quota level was based on the mean of the total catch in 1974-1976, but did not correct for the fact that only seven of the eight vessels were active in 1974 and 1976. The resulting quota was 68 t/vessel.

The quota was removed from vessels fishing Div. 5Ze in 1977, along with the season restrictions, when it became apparent that removal of Canadian gear would only result in a loss of grounds to American vessels and would serve no conservation value.

Unlike other quota fisheries which have quotas based on biomass estimates, the offshore lobster quota is simply based on the mean catches of the fishery's fourth to sixth years. The quota has remained unchanged for nine years even though it is recognized that the offshore fishery was not the cause of the low 1976 inshore landings; that the fears of rapid exponentially increasing offshore effort were unfounded, that to date no direct connection has been shown between inshore and offshore abundance, and that there are no indications that the fishery has had a visible effect on the size frequency of the offshore stock. The recent increase in inshore landings to near-record levels further suggests there has been no direct detrimental impact by the offshore fishery (Figure 11).

Browns Bank Closed Area

The closed area was established in 1979 as a refugium for offshore lobster brood stock which was hypothesized to be important to the recruitment of inshore lobsters of Southwestern Nova Scotia (Stasko 1978). The offshore fishery had operated along the southern edge of the Bank year round and a growing spring inshore fishery operated in the shoalwater on the northwest of the Bank (Figure 2). The concept appears to have developed at the 1978 Canada/USA lobster workshop and was formalized in January 1979. Prior to the closure, no data on the population size, distribution, or size structure had been collected or presented.

Designed to protect the brood stock believed to be on the

Bank, the closed area was defined as a rectangular area which enclosed all areas of the Bank <50 fm (<91 m). As a result the box included large areas off the Bank and in deep water. The closure area stopped the developing inshore fishery on the Bank, and removed one third of the Div. 4X offshore fishing grounds which had supported two to three vessels.

The retention of the deep-water sections of the closed area have since been justified on the basis of providing year-round protection to a portion of the stock. Tagging data indicate movement in and out of the area; but a 1984 spring survey along the northern edge of the Northeast Channel found large concentrations of very large animals, suggesting a portion of the population has been protected from fishing mortality. Data from the 1975 tagging program showed a large concentration of juvenile lobsters in the shoal regions, though subsequent sampling has yet to confirm the existence of a large population of juveniles in that area. If a juvenile nursery area exists, it should be protected to assure a continuous supply of lobsters to the fishery.

Ideally the closed area should be large enough to protect that portion of the stock deemed to need protection but small enough not to unnecessarily hinder the fishery. Results from upcoming surveys will allow a reassessment of the closed area in 1986, based on distribution, size structure, and movement data.

Management Options

1) Under the current quota system, the season and trap limit serve no conservation value in Div. 4X and could be eliminated or modified. The trap limit in Div. 5Ze may reduce catches by decreasing fishing efficiency, but it may be too restrictive considering the higher operating cost and lower value per pound of the larger lobsters from Georges Bank.
2) The conservation value of the closed area is currently being assessed and changes are not suggested at this time. Ongoing research is investigating the question of lobster distribution, movement, and population size stucture within the closed area.
3) Following the World Court decision, which allotted the northeast peak of Georges Bank to Canada, it was suggested that the boat quota system be extended to Div. 5Ze. A simple extension of the Div. 4X quota would ignore the higher operating cost (larger vessels, longer trips, greater gear loss), the lower value per pound of the larger lobsters, and the historically higher catch rates. The vessels fishing Div. 5Ze averaged 89 t per vessel between 1975 and 1984 (50-129 t). No biomass estimates or complete landing records (Canadian and USA) exist which would allow a quota to be set for Div. 5Ze. Recent landings may have been depressed due to American competition or to cyclical changes in lobster abundance and should not be used to set future quota levels.

The Canadian portion of Georges Bank represents only a small portion of the Georges Bank lobster stock area and some

seasonal and longer-term cross-border movements can be expected. The shallow Georges shoal to which mature lobsters appear to migrate in summer and which may support juvenile lobsters lies completely within the American zone and heavy American fishing could have a detrimental effect on the Canadian catch. A reduction or restriction of Canadian effort may have little conservation value. It is suggested that no restrictive measures be imposed until the potential catch is better determined.

4) The Div. 4X quota should be evaluated in light of its non-biological basis and lack of any noticeable impact of the offshore fishery on the offshore size frequency or the inshore catch levels. Without biomass estimates any quota set will be arbitrary and must be periodically reviewed.
5) The Div. 4X quota area could be extended to include the entire Northeast Channel and Georges Basin area. Canadian vessels have never extensively fished the southern half of the channel, but American vessels have been active in the area with both traps and trawls. Georges Basin appears to represent the possible winter habitat of lobsters caught on western Browns Bank, and inclusion of the area under the quota would prevent the fishing of Browns Bank lobsters outside of the quota system. As long as effort remains low it is recommended that no extension of the quota area occur until the potential of the area and its relationship to Browns and Georges Banks are studied. An extension of the quota area without a corresponding increase in the quota would result in a potential decrease in overall catch and is not recommended.

References

Austin, C.B. 1977. Incorporating soak time into measurements of fishing effort in trap fisheries. Fish. Bull. 75: 213-15.

Bennett, D.B. 1974. The effects of pot immersion time on catches of crabs, Cancer pagurus and lobster Homarus gammarus. J. Cons. int. Explor. Mer. 35: 332-336.

Bennett, D.B. and C.G. Brown 1979. The problem of pot immersion time in recording and analysing catch effort data from a trap fishery. Rapp. P.-v. Reun. Cons. int. Explor. Mer 175: 186-189.

Cooper, R.A. and J.R. Uzmann. 1980. Ecology of juvenile and adult Homarus, p. 97-142. In J.S. Cobb and B.F. Phillips (ed) Biology and Management of Lobsters, Vol. 2. Academic Press, N.Y., 390p.

Fogarty, M.J., R.A. Cooper, J.R. Uzmann, and T. Burns. 1982. Assessment of the U.S.A. offshore lobster (Homarus americanus) fishery. Int. Coun. Explor. Sea C.M.1982/K:14

Hernick, F.H. 1909. Natural history of the American lobster.

Bull. Bureau Fish. 29: 153-408.

Hilborn, R. and M. Ledbetter. 1985. Determinants of catching power in the British Columbia salmon purse seine fleet. Can. J. Fish. Aquat. Sci. 42: 51-56.

Mountain, D.G. 1982. Oceanographic conditions in NAFO Subareas 5 and 6 during 1970-79. NAFO Sci. Counc. Studies 5: 95-100.

Pezzack, D.S. 1983. Distribution of American lobster (Homarus americanus) in the midshore and offshore regions of S.W. Nova Scotia during October 1980, July 1981 and October 1981 trap surveys. Can. Atlantic Fish. Sci. Adv. Comm. Res. Doc. 83/67.

Pezzack, D.S. and D.R. Duggan. 1983. The Canadian offshore lobster (Homarus americanus) fishery 1971-1982. Int. Coun. Explor. Sea. Shellfish Comm. C.M.1983/K:34.

Ricker, W.E. 1940. Relation of "catch per unit effort" to abundance and rate of exploitation. J. Fish. Res. Board Can. 5: 43-70.

---------- 1975. Computation and interpretation of biological statistics of fish populations. Bull. Fish. Res. Board Can. 191, p. 382.

---------- 1977. The historical development. In J.A. Gulland (ed.) Fish Population Dynamics. John Wiley and Sons, London.

Rothschild, B.J. 1977. Fishing effort. In J.A. Gulland (ed.), Fish Population Dynamics. John Wiley and Sons, London.

Stasko, A.B. 1978. Inshore-Offshore S.W. Nova Scotia lobster stock interaction: A hypothesis. Can. Atl. Fish. Sci. Adv. Comm. Res. Doc. 78/37, 10 p.

Stasko, A.B. and R.W. Pye. 1980a. Canadian offshore lobster fishery trends. Can. Atl. Fish. Sci. Adv. Comm. Res. Doc. 80/56.

---------- 1980b. Geographic differences in Canadian offshore lobster. Can. Atl. Fish. Sci. Adv. Comm. Res. Doc. 80/57. 12 p.

Skud, B.E. 1969. The effects of fishing on size composition and sex ratios of offshore lobster stocks. Fisk. Dir. Skr. Ser. Havunderes. 15: 295-309.

---------- 1979. Soak time and catch per pot in an offshore fishery for lobsters (Homarus americanus). Rapp. P. v. Reun. Cons. int. Explor. Mer 175: 190-196.

Uzmann, J.R., R.A. Cooper and K.J. Pecci. 1977. Migration and

dispersion of tagged American lobsters, Homarus americanus, on the southern New England continental shelf. NOAA Tech. Rep. NMFS SSRF 705.

Venning, R.N. 1910. The marine and fisheries committee and lobster industry. A special appended Report II. Marine and Fisheries Ottawa, Canada Annual Reports sessional paper No. 22.

Table 1. Canadian offshore lobster landings in t (% of total in parenthesis) and landed value by area fished as reported in fishermen's logs. Landings are based on fishermen's logs, Fisheries Officers' reports, and sales slips. Where log records were not available, locations are estimated on the basis of previous and subsequent locations fished by each boat. Landed value is based on sales slips.

		Landings (%)								
Year	No. of vessels	West Browns (4XP, 4XQ)		Southeast Browns (4XN)		Total 4X		Georges Bank (5Ze)		Total (4X + 5Ze)	Landed Value ($,000)
1971	5			8	(8)	8	(8)	92	(92)	100	177
1972	6	22	(7)	158	(47)	180	(54)	154	(46)	334	785
1973	7	136	(27)	181	(37)	317	(64)	176	(36)	493	1,166
1974	6	132	(32)	149	(36)	281	(68)	135	(32)	416	1,059
1975	8	171	(31)	201	(37)	372	(68)	173	(32)	545	1,527
1976	7	378	(56)	118	(17)	496	(73)	182	(27)	678	2,167
1977	8	290	(46)	68	(10)	358	(56)	277	(44)	635	1,971
1978	8	297	(43)	84	(12)	381	(56)	303	(44)	684	2,249
1979	8	215	(35)	158	(26)	373	(61)	236	(39)	609	2,175
1980	8	147	(27)	210	(38)	357	(65)	192	(35)	549	2,066
1981	7	136	(24)	247	(43)	383	(67)	189	(33)	572	2,348
1982	8	135	(30)	142	(32)	277	(62)	173	(38)	450	2,232
1983	8	200	(42)	114	(24)	314	(66)	156	(33)	470	2,650
1984	7	153	(35)	118	(27)	271	(62)	164	(38)	435	2,621

Table 2. Catch (t), effort (,000's of trap hauls), and CPUE (kg/TH) for the subareas of the Canadian offshore lobster fishing district, based on log books, fishery officer reports, and sales slips.

Year	West Browns 4XP, 4XQ			SE Browns 4XN			Total 4X*			Georges Bank 5Ze			Total Canadian offshore*			% of Catch in log books
	C	E	CPUE	C	E	CPUE	C	E	CPUE	C	E	CPUE	C	E	CPUE	
1971	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
1972	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
1973	56.3	20.2	2.79	4.7	2.3	2.10	61.0	22.4	2.72	139.7	45.5	3.07	200.7	68.0	2.95	41
1974	127.9	63.9	2.00	22.3	15.4	1.45	150.3	79.3	1.89	127.9	55.3	2.31	278.2	134.6	2.07	67
1975	171.1	96.9	1.77	102.0	44.0	2.32	273.2	141.0	1.94	173.1	58.6	2.95	446.2	199.5	2.24	82
1976	356.9	136.2	2.62	102.8	51.2	2.01	459.7	187.4	2.45	160.4	50.8	3.16	620.1	238.2	2.60	91
1977	250.4	101.8	2.46	53.2	27.3	1.94	322.4	136.5	2.36	238.9	83.3	2.87	602.2	240.0	2.51	95
1978	267.8	98.3	2.73	64.6	27.7	2.33	380.7	135.2	2.82	303.3	94.3	3.22	684.0	229.5	2.86	100
1979	214.5	85.6	2.51	158.1	55.1	2.87	372.6	140.7	2.65	235.9	76.1	3.10	608.6	216.8	2.81	100
1980	147.3	66.3	2.22	187.4	61.9	3.03	334.7	128.2	2.61	183.6	57.2	3.21	518.3	185.4	2.80	95
1981	135.8	52.5	2.59	247.3	61.0	4.06	383.1	113.5	3.38	189.1	48.0	3.35	572.2	161.5	3.54	100
1982	134.7	67.6	1.99	141.6	78.0	1.82	276.3	145.6	1.90	173.7	64.7	2.68	450.0	210.2	2.14	97
1983	199.7	95.6	2.09	113.9	51.4	2.22	313.6	146.9	2.13	156.5	81.8	1.91	470.1	228.0	2.06	99
1984	153.1	72.7	2.10	117.5	49.0	2.40	270.6	121.7	2.22	164.0	75.7	2.17	434.6	197.4	2.20	99

*Some trips could not be broken down into specific areas, but were included in the total for the combined Area 4X and/or yearly totals; thus, area or yearly totals can be greater than the sum of the parts.

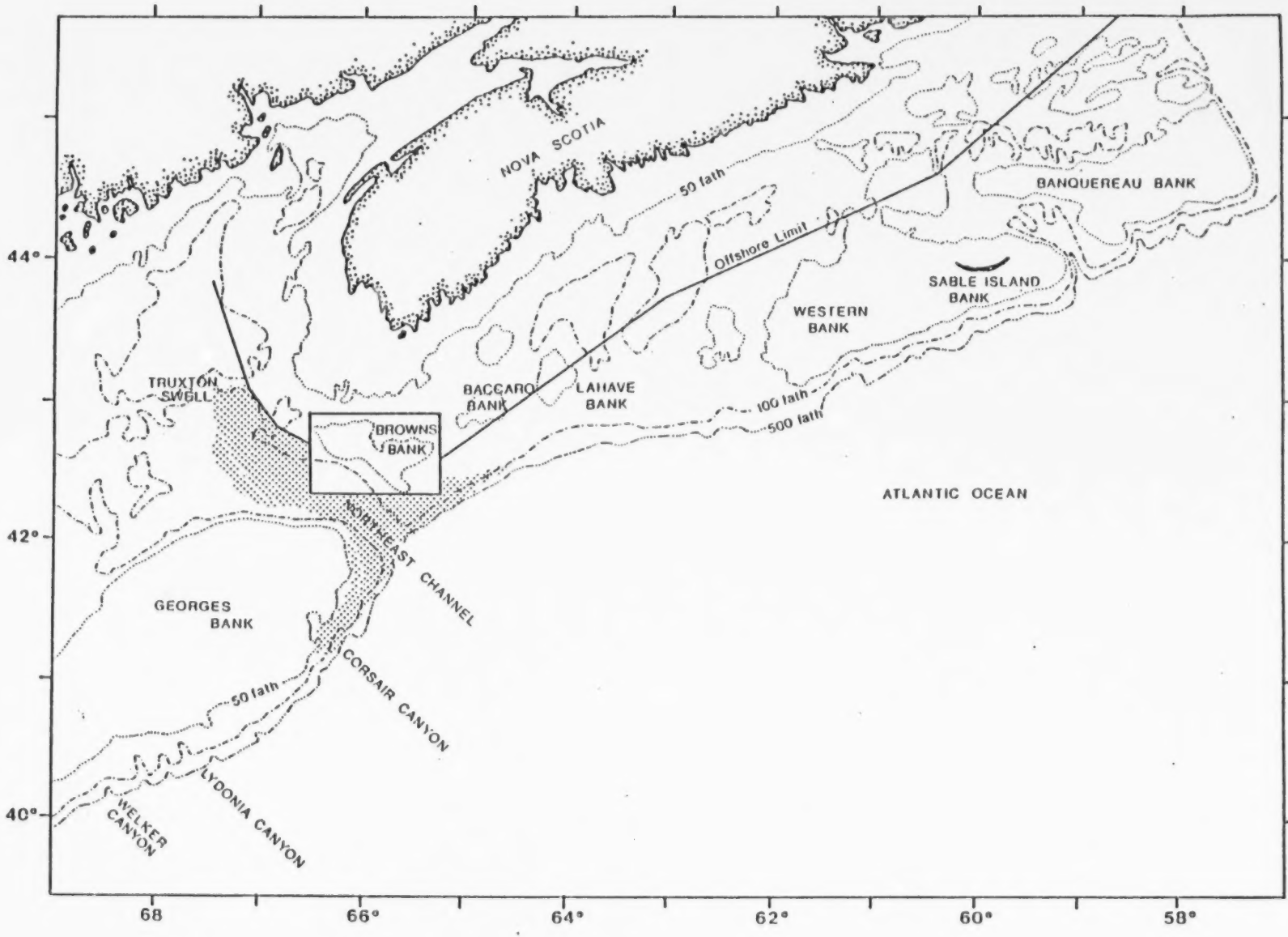
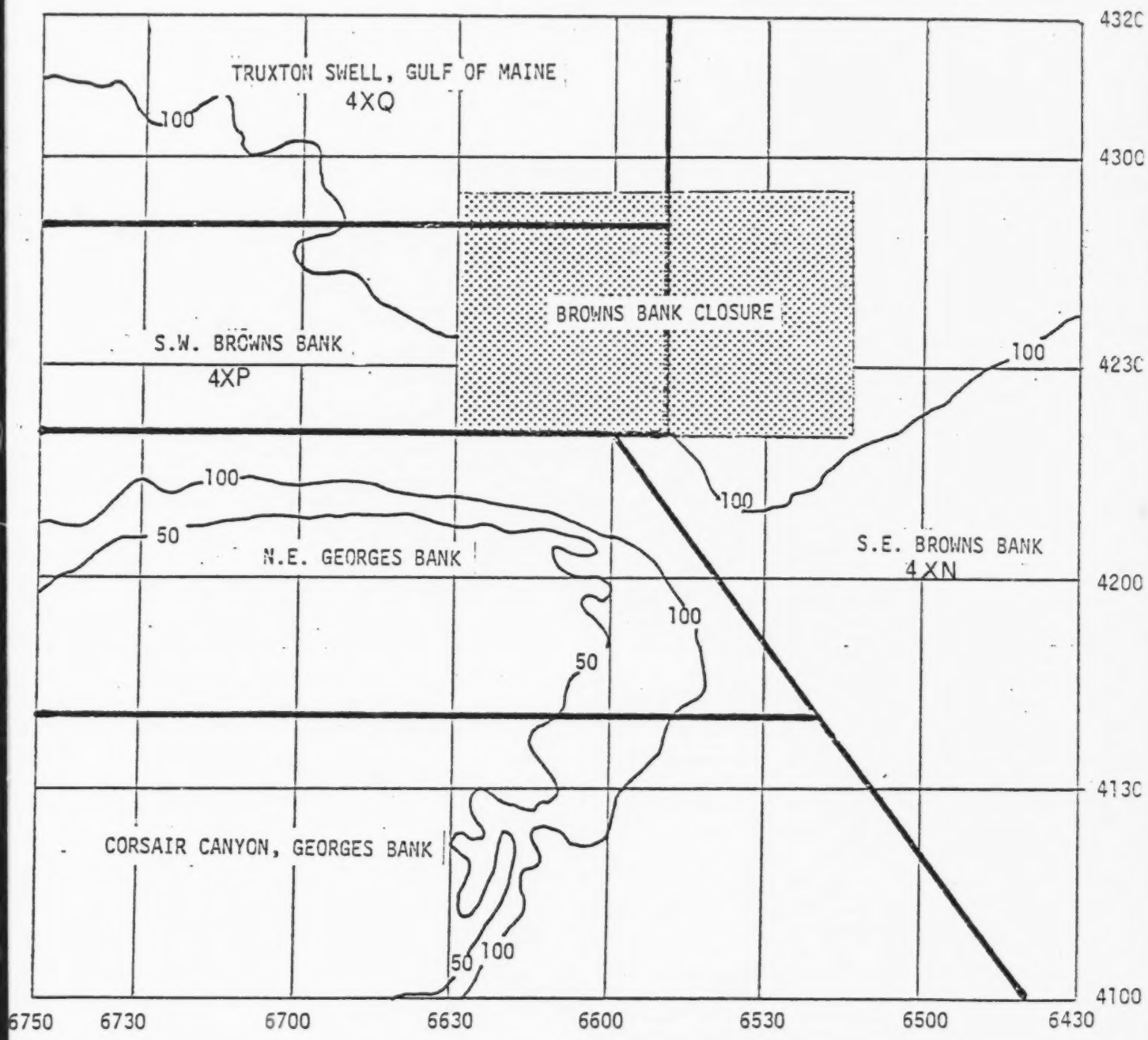


Fig. 1. Offshore Lobster District A, showing Canadian offshore fishing areas.

OFFSHORE LOBSTER AREAS



Truxton Swell, Gulf of Maine
S.W. Browns Bank
S.E. Browns Bank
N.E. Georges Bank
Corsair Canyon, Georges Bank

W. Browns

Georges

Fig. 2. Offshore lobster assessment areas.

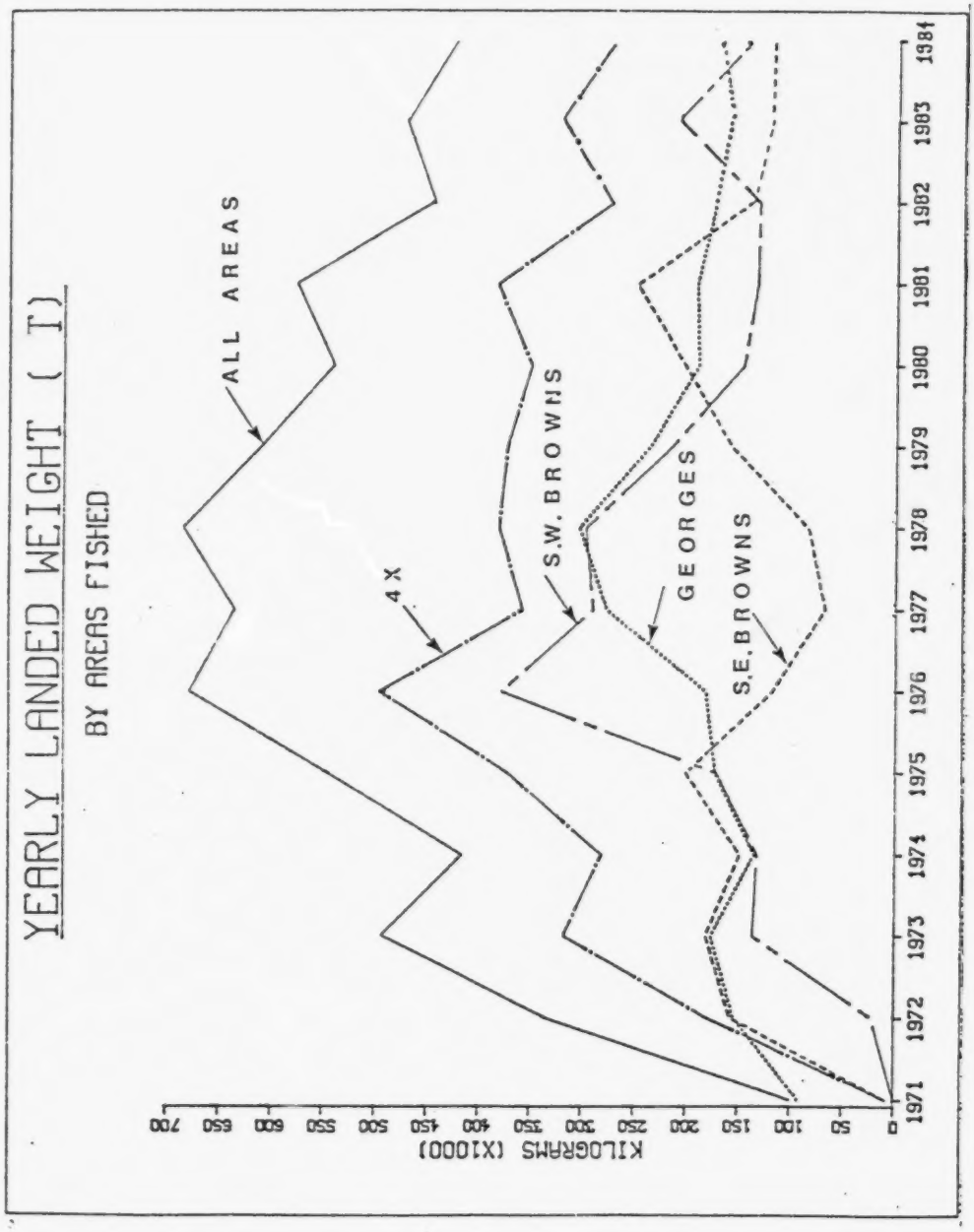


Figure 3 Total landed weight (t) by area fished, 1971 to 1984. Data are taken from fishermen's logbooks, sales slips, and fisheries officers' reports.

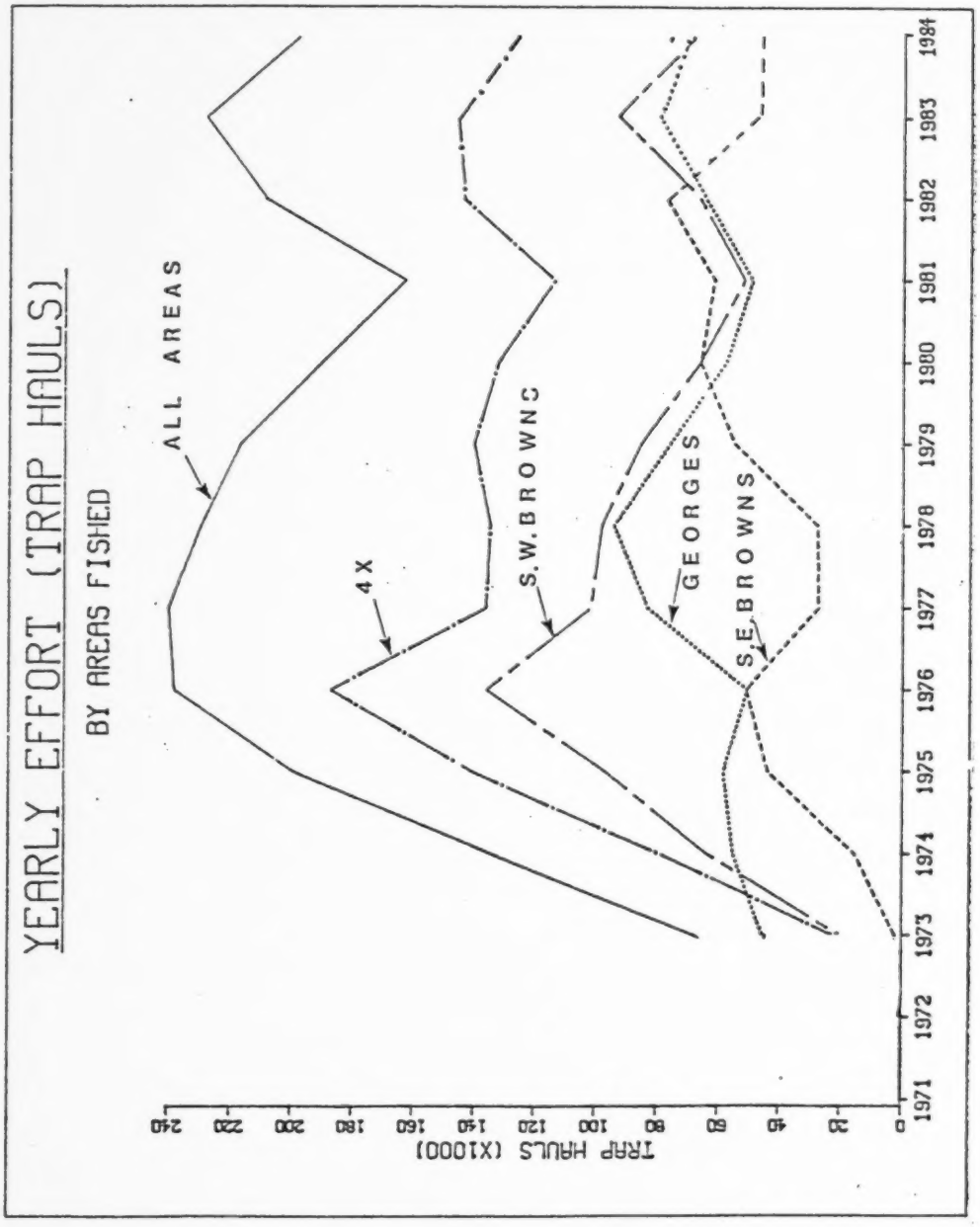


Figure 4. Total reported effort (trap hauls) by area fished, 1973 to 1984. Data are from fishermen's logbooks.

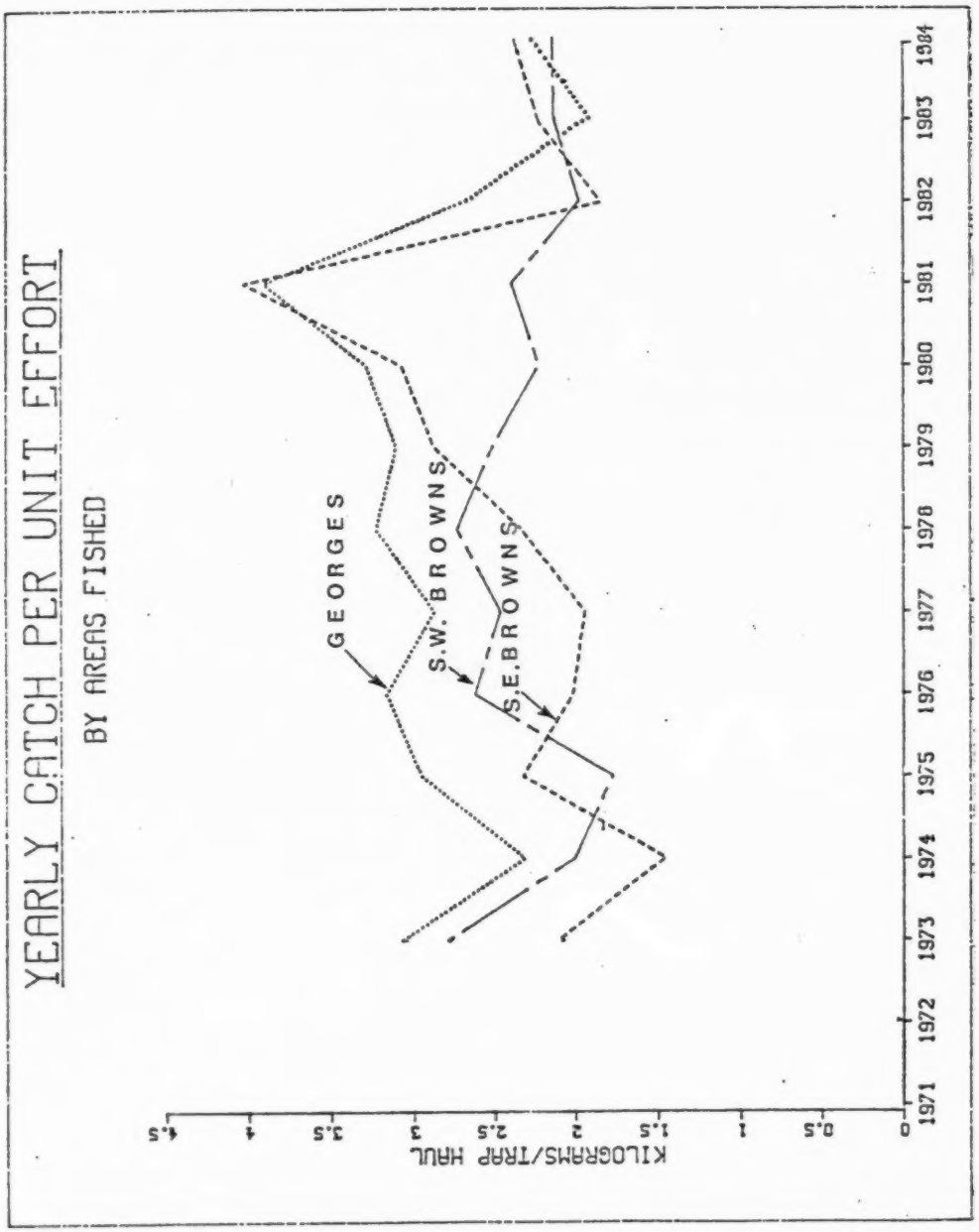


Figure 5 Mean CPUE (kg/TH) by area fished. Data are calculated from fishermen's logbooks and sales slips.

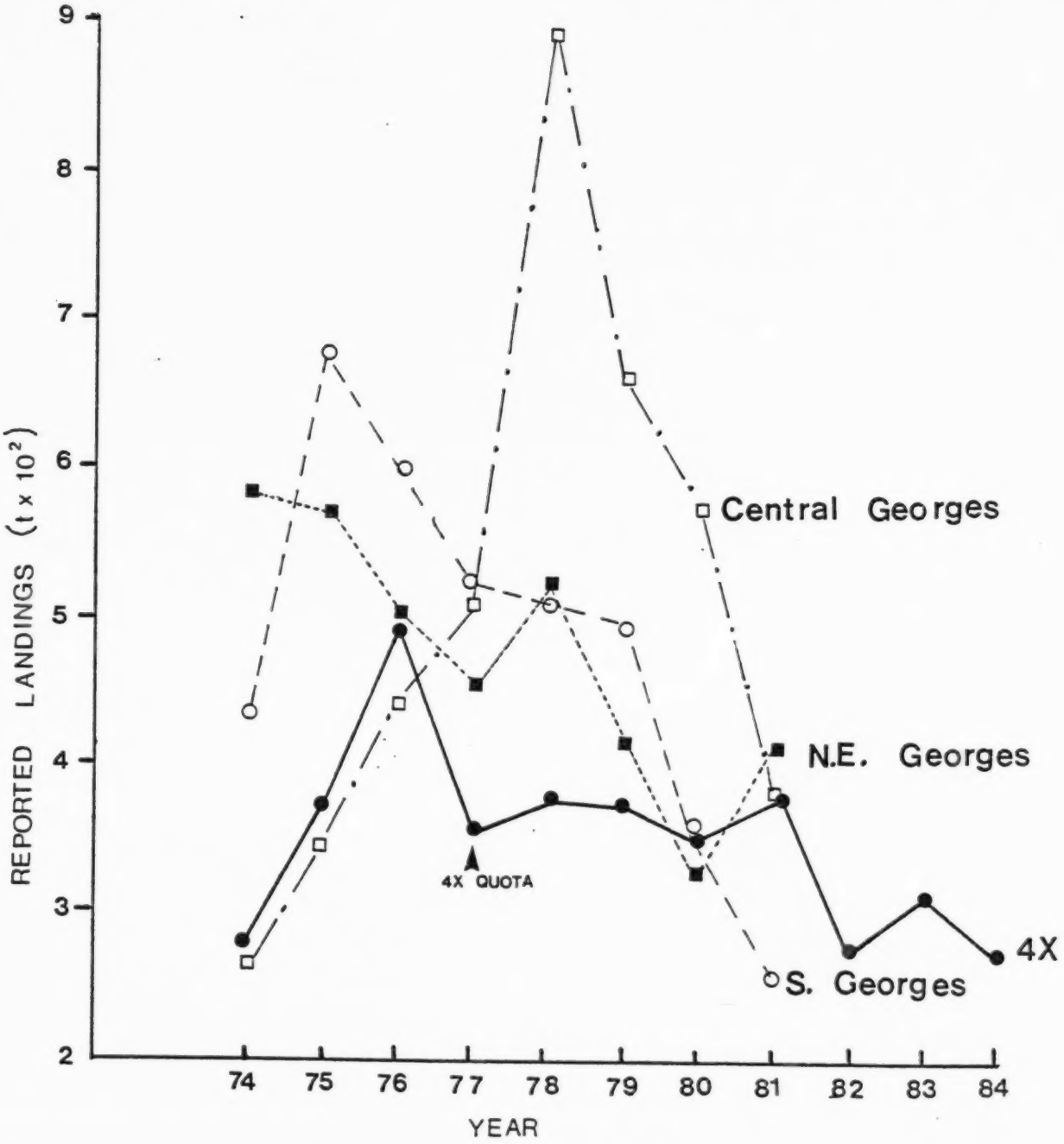


Fig. 6. Reported offshore lobster landings from 4X, northeastern Georges Bank (5Zm, 5Zj), central Georges Bank (5Zh, 5Zn), and southern Georges Bank (5Zo, 5Zj)
Canadian data from offshore lobster logbooks and sales slips. (USA landings supplied by M. Fogarty, National Marine Fisheries Service.)

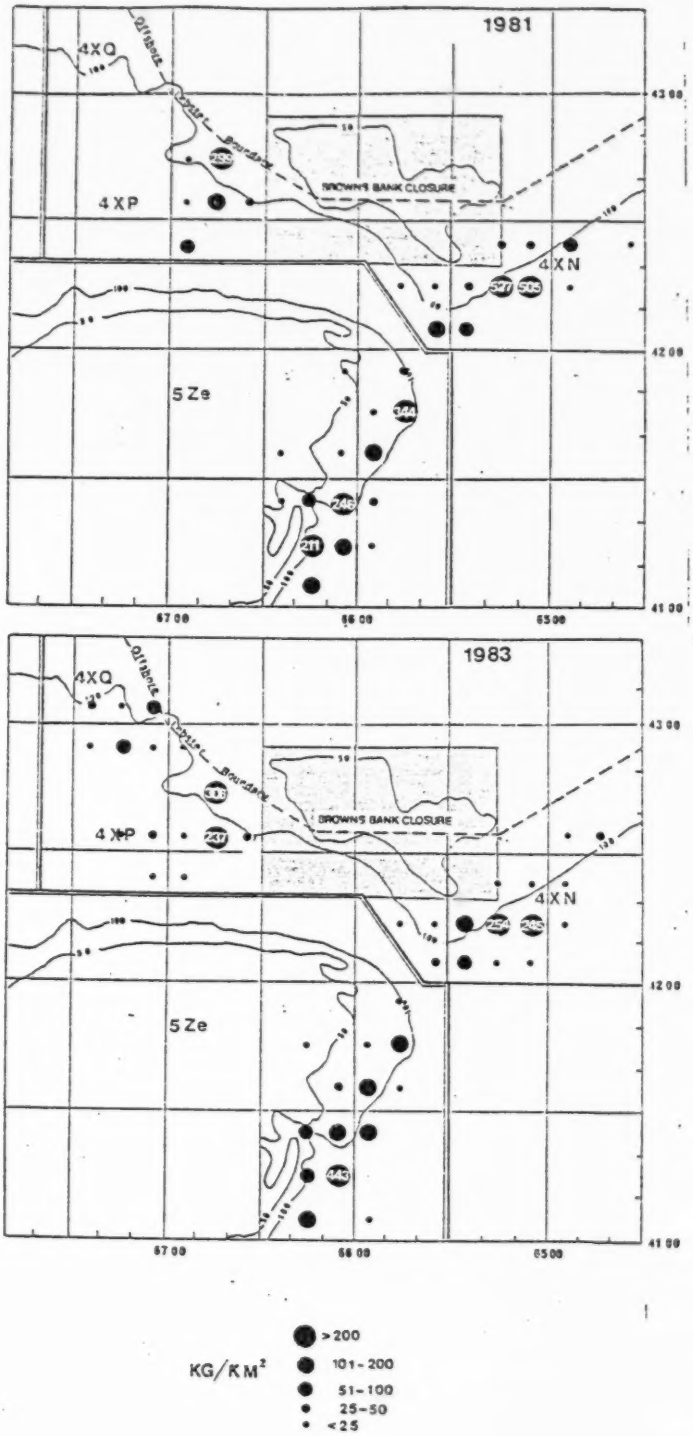


Fig. 7. Kilograms of lobster caught per square kilometer in each 10' x 10' square fished - 1981 and 1983.

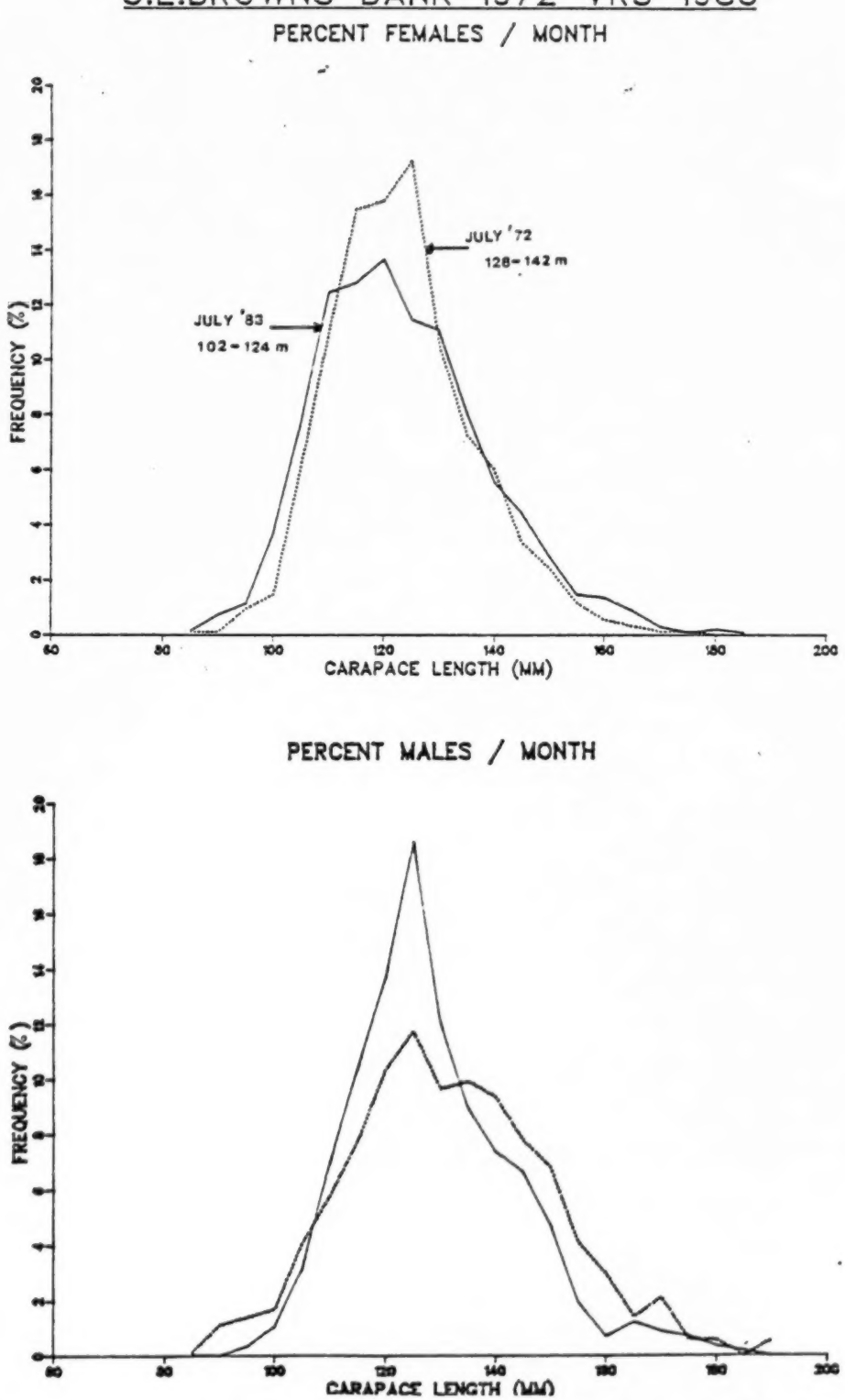


Fig. 8. Size-frequency distribution of male and female lobsters caught in July 1972 and July 1983 at-sea samples on commercial vessels fishing southeastern Georges Bank. Frequencies are plotted by 5 mm size groups, and fishing depth is in meters.

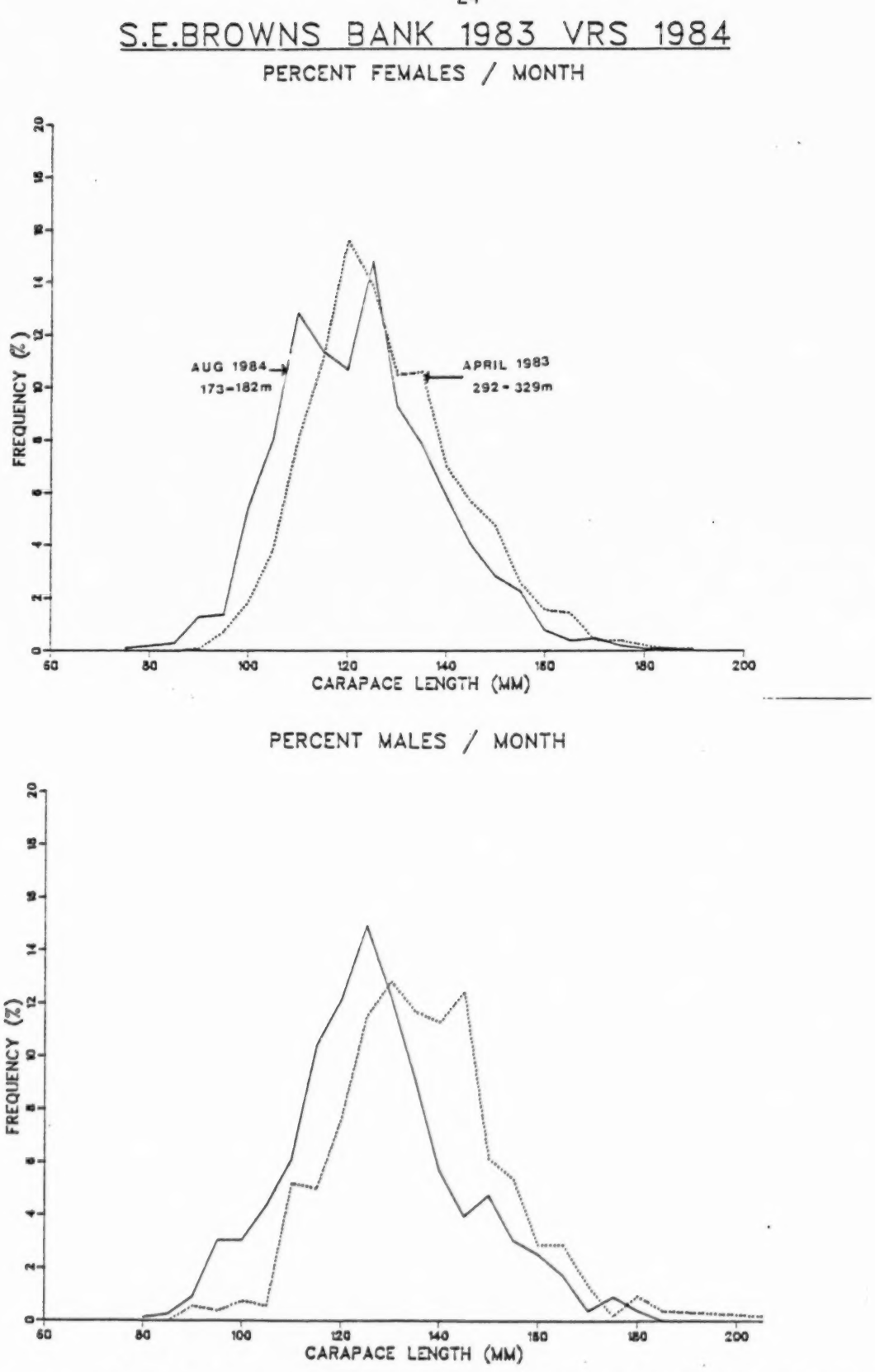


Fig. 9. Size-frequency distribution of male and female lobsters caught in April 1983 and August 1984 at-sea samples on commercial vessels fishing southeastern Georges Bank. Data illustrate seasonal extremes in fishing depth and size frequency.

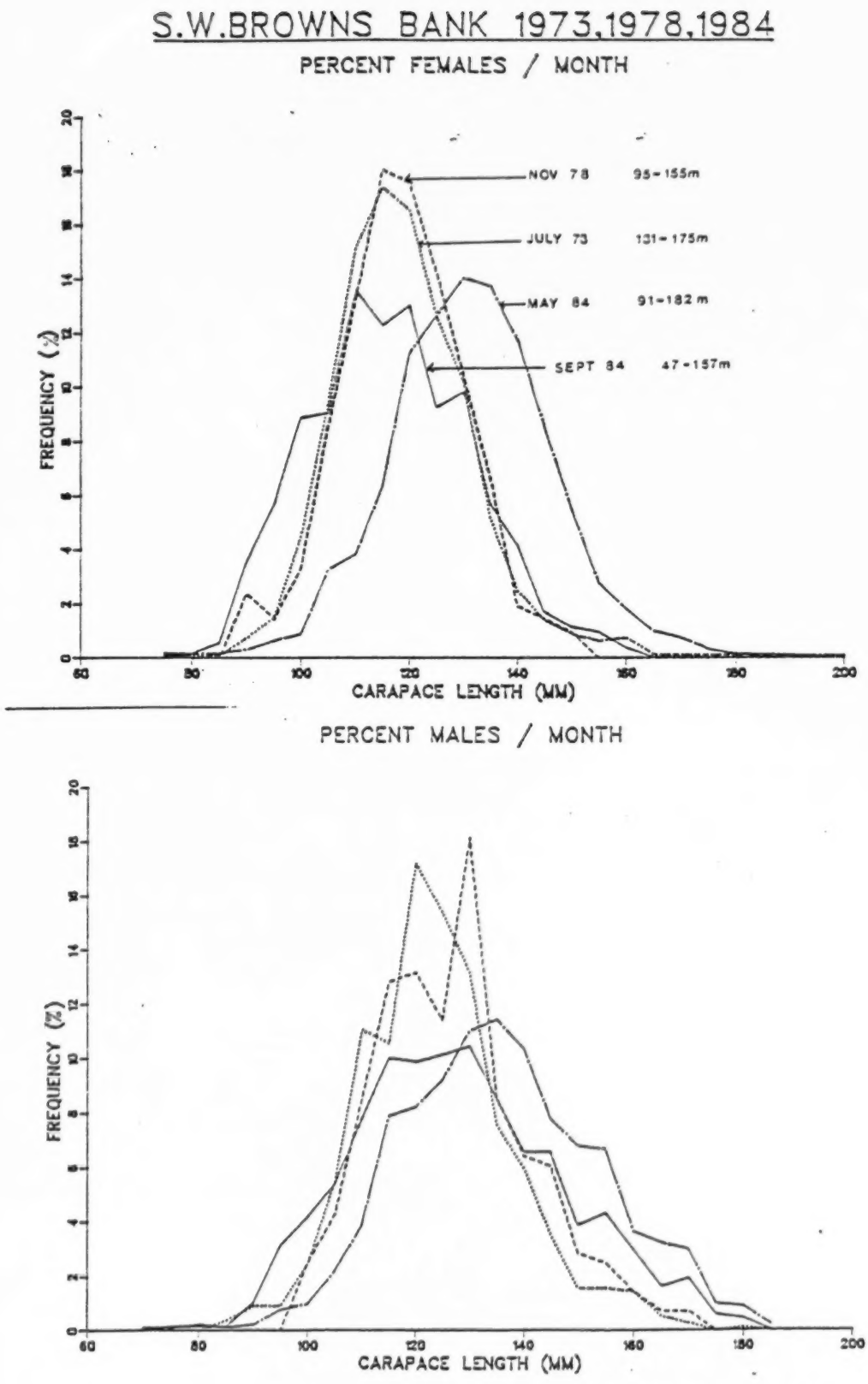


Fig. 10. Size frequency distribution of male and female lobsters caught in July 1973 and November 1978 at-sea samples of commercial vessels and May 1984 and September 1984 research trapping surveys on the section of western Browns Bank presently in a closed

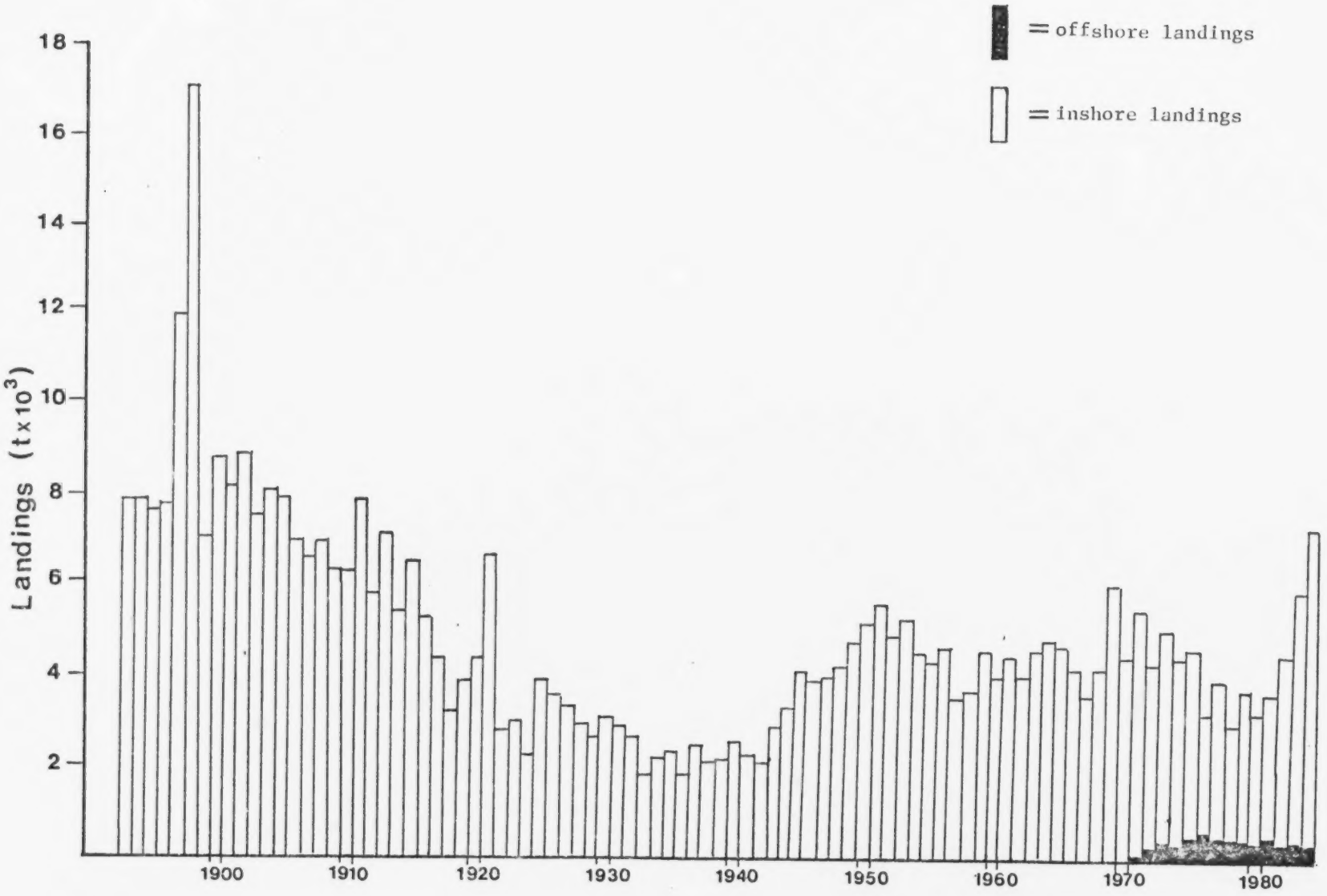


Fig. 11. Reported lobster landings for Lobster District 4 for 1893 to 1984 and Offshore Lobster District A, 1971 to 1984. Landings are in thousands of metric tonnes.